Ideal Cardiovascular Health Among American Adults After the Economic Recession of 2008–2009: Insights from NHANES

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Abstract

BACKGROUND: The economic recession of 2008–2009 resulted in unprecedented employment and economic losses leading to deterioration of cardiovascular health. We examined the trends in ideal cardiovascular health as measured by the American Heart Association's (AHA's) Life's Simple 7 metric during the periods of economic recession and subsequent economic recovery.

METHODS: Data on adults ages ≥ 20 years from the NHANES from economic-recession (2007–2010) and post-recession (2011–2016) periods was analyzed. The AHA's Life's Simple 7 score of 10–14 was used to classify ideal cardiovascular health status. Socioeconomic status was divided into 3 categories: high, middle, and low based on education and income status. Multivariable linear and logistic regression models including demographics, insurance status, health care access, and adjustment for multiple testing were used to analyze the trends in prevalence of ideal cardiovascular health across socioeconomic strata.

RESULTS: We observed a decline in the multivariable-adjusted mean cardiovascular health score from 8.18 in 2007–2010 to 7.94 in 2015–2016 (P_{linear} = 0.02). This was primarily driven by the increasing prevalence of obesity (34% in 2007–2010 vs 41% in 2015–2016, P_{linear} = 0.005) and poor fasting glucose (8% in 2007–2010 vs 12% in 2015–2016, P_{linear} = 0.003). In multivariable-adjusted models, we observed the decreasing prevalence of ideal cardiovascular health with a nonlinear trend in the participants in the highest (51% in 2007–2010 vs 42% in 2015–2016, $P_{quadratic}$ = 0.01) and lowest socioeconomic strata (16% in 2007–2010 vs 13% in 2015–2016, $P_{quadratic}$ = 0.02). The prevalence of ideal cardiovascular health was higher in participants with high-socioeconomic status compared with other socioeconomic status participants.

CONCLUSIONS: Despite economic recovery, ideal cardiovascular health metrics have not yet recovered. Cardiovascular health appears to be further deteriorating for US adults, particularly those in high- and lower-socioeconomic strata.

Keywords

INTRODUCTION

Economic downturn can impact the general health of the population.[1,2] The effect on cardiovascular health may be particularly profound.[3] From the mid 2000s to 2010, there was a significant economic decline with a concomitant deterioration in population-level health.[4,5] This period was characterized by a staggering rise in unemployment and financial losses and has, therefore, been widely accepted as a period of economic recession.[6] A prior population-based cohort study has shown the deleterious effects of the economic recession on blood pressure and blood glucose levels in the United States.[3] There has also been evidence to suggest that economic recession had varying degrees of adverse effects on population health among subgroups (eg, younger vs older individuals, women vs men, whites vs other races, higher vs lower level of educational attainment).[1,3,7–9]

The AHA's Life's Simple 7 is a relatively simple metric to capture the state of cardiovascular health at the population level.[10] The Life's Simple 7 is composed of the following 7 metrics that can be used to signify "ideal cardiovascular health": nonsmoking, body mass index (BMI) less than 25 kg/m^2, physical activity at goal levels, diet consistent with current guideline recommendations, total cholesterol less than 200 mg/dL, blood pressure less than 120/80 mm Hg, and fasting serum glucose less than 100 mg/dL.[11] A poor status of Life's Simple 7 score has been associated with multiple adverse cardiovascular outcomes such as incident heart failure,[12,13] atrial fibrillation,[14] and prognosis after myocardial infarction.[15]

We hypothesized that the macroeconomic fluctuations noted during the economic recession and the subsequent economic recovery would be associated with cardiovascular health metrics of US adults ages 20 years and older. Furthermore, we hypothesized that the age, sex, race, insurance status, access to health care adjusted time trends in prevalence of ideal cardiovascular health, as captured by Life's Simple 7 metrics, varied among adults from different socioeconomic strata. We used the National Health and Nutrition Examination Survey (NHANES) from 2007 to 2016 to evaluate our hypotheses.

METHODS

Data Source and Study Population

We used the data from participants of 5 NHANES cycles spanning from 2007–2008 to 2015–2016.[16] Description of NHANES data set is briefly outlined in Supplemental Method 1 (Online Appendix A). Participants prior to 2007–2008 (prerecession period) were not included in the study because of significant changes in the measurement and coding of

physical activity (ie, a component of Life's Simple 7 metrics) in NHANES from 2007–2008 onward.[17] Furthermore, there is a lack of availability of NHANES data during the period of 2008–2009 as a separate data set. In an effort to keep the longitudinal assessment and coding constant while examining NHANES cycles for the impact of the economy on cardiovascular health, we performed the following steps to identify study participants: 1) we merged the data sets from 2007 to 2010 NHANES surveys into 1 period to classify these survey years as a period of economic recession; and 2) the data from the NHANES survey years 2011 to 2016 were treated as separate data sets to assess trends in the postrecession or economic recovery period. The flow chart for selection of the study population is outlined in Supplemental Figure 1 and Supplemental Method 2 (Online Appendix A). As NHANES dataset contains deidentified publicly available data, this study was exempt from IRB of the University of Alabama at Birmingham.

Age and sex were self-reported. Self-reported race and ethnicity was categorized into 4 levels: non-Hispanic whites, non-Hispanic blacks, Mexican American, and others. Health insurance status (Yes/No) and total number of health care visits in past 1 year were also self-reported. These measures were included as surrogates for health care access.

Definition of Cardiovascular Health Metrics

The cardiovascular health metrics were identified using the AHA's Life's Simple 7 behavioral and health factors. The Life's Simple 7 metrics are grouped into the ideal health behaviors (ie, smoking status, BMI, physical activity, and healthy diet score) and ideal health factors are (ie, total cholesterol, blood pressure, and fasting plasma glucose). Each cardiovascular health metric was categorized into the ideal, intermediate, and poor categories and given a point score of 2, 1, and 0, respectively (Supplemental Table 1, Online Appendix A).[10,11] The NHANES questionnaire list was used to identify the self-reported smoking status (ie, current, former, or non-smoker) (Supplemental Table 1). The BMI was calculated based on the anthropometric parameters that were measured by the trained health technician during the mobile examination. The manner in which we classified subjects' physical activity levels and the healthy diet score is outlined in detail in Supplemental Method 3 (Online Appendix A). As outlined in a previous study,[18] the poverty income ratio and years of education were used to categorize the socioeconomic status (Supplemental Method 4, Online Appendix A).

Statistical Analysis

SAS version 9.4 (SAS Institute Inc., Cary, NC) was used to perform all of the statistical analyses. Detailed description of all the statistical analyses including sensitivity analysis is outlined in Supplemental Method 5 (Online Appendix A).

RESULTS

Table 1 outlines the age-standardized weighted sample characteristics for each of the NHANES cycles included in our study. As shown, the demographic and socioeconomic characteristics of the study participants were similar across the NHANES survey cycles (Table 1). The mean age of study participants was 45 years, 51% were females, and ~67%

were non-Hispanic whites from 2007–2010 through 2015–2016 (Table 1). The proportion of participants in the different strata of socioeconomic status (a combination of education and income status) remained similar during the study period (Table 1). There was a modest increase (~6%) in the proportion of individuals with insurance from 2007–2010 to 2015–2016 (Table 1).

Overall Trends in Cardiovascular Health

As described in Table 2, the prevalence of obesity (BMI   30 kg/m^2) significantly increased from 2007–2010 to 2015–2016 (P_{linear} =0.005). Additionally, the prevalence of ideal fasting blood glucose showed a quadratic trend ($P<0.001$), initially increasing from 2007–2010 to 2013–2014, but then decreasing in 2015–2016. The prevalence of cardiovascular health metrics such as smoking, physical activity, healthy diet score, total cholesterol, and blood pressure remained unchanged (P_{linear} and $P_{quadratic}$ >0.05).

From the economic recession to the economic recovery period, the age, sex, race, insurance status, and number of health care visits adjusted mean cardiovascular health score decreased marginally, albeit significantly, from 8.18 (95% confidence interval [CI] 8.07–8.29) in 2007–2010 to 7.94 (95% CI 7.73–8.16) in 2015–2016 (P_{linear}=0.02; Table 2). Odds of fasting blood glucose   126 mg/dL were 25% higher (95% CI 1.03–1.52) and obesity were 15% (95% CI 1.01–1.30) higher in the postrecession survey cycles (2011–2016) compared with the recession period (2007–2010; Table 3).

Among participants with high socioeconomic status, the mean cardiovascular health score, adjusted for age, sex, race, insurance status, and number of health care visits, decreased from 9.4 (95% CI 8.9–9.8) in 2007–2010 to 8.7 (95% CI 8.2–9.3) in 2015–2016 (P_{linear} =0.007) (Figure 1, Panel A). However, among lower socioeconomic strata, the adjusted mean cardiovascular health score increased from 7.4 (95% CI 6.6–8.1) in 2007–2010 to 8.4 (95% CI 7.7–9.2) in 2011–2012 and then subsequently declined to 7.0 (95% CI: 6.0–8.0) in 2015–2016 ($P_{quadratic}$ =0.007). In the higher socioeconomic strata, there was a decline in the prevalence of ideal cardiovascular health from 51% in 2007–2010 to 42% in 2015–2016 ($P_{quadratic}$ =0.01; Figure 1, Panel B). However, among lower socioeconomic strata, the prevalence of ideal cardiovascular health increased from 16% in 2007–2010 to 26% in 2011–2012 and then declined to 13% in 2015–2016 ($P_{quadratic}$ =0.02). We did not observe any trend in the mean cardiovascular health score or the prevalence of ideal cardiovascular health among participants in the middle socioeconomic stratum (P_{linear} and $P_{quadratic}$ >0.05; Figure 1, Panels A and B).

Cardiovascular Health Stratified by Socioeconomic Status: High Socioeconomic Status

In the highest socioeconomic stratum, the prevalence of participants with a BMI above 30 kg/m^2 increased significantly from 30% (95% CI 26%–34%) in 2007–2010 to 42% (95% CI 36%–48%) in 2015–2016 (P_{linear} =0.003; Table 4). Similarly, the prevalence of participants with a fasting blood glucose above 126 mg/dL significantly increased from 6% (95% CI 5%–8%) in 2007–2010 to 12% (95% CI 8%–16%) in 2015–2016 (P_{linear} =0.04). The prevalence of participants with ideal physical activity showed a quadratic trend ($P = 0.002$), decreasing from 55% in 2007–2010 to 46% in 2013–2014 but then increased to 54% in

2015–2016. The prevalence of other ideal cardiovascular health metrics remained unchanged from 2007–2010 to 2015–2016 (P_{linear} and $P_{quadratic}$ >0.05).

Cardiovascular Health Stratified by Socioeconomic Status: Middle Socioeconomic Status

Among subjects in the middle socioeconomic stratum, the prevalence of fasting blood glucose above 126 mg/dL increased significantly from 8% (95%CI 7%–10%) in 2007–2010 to 12% (95%CI 9%–14%) in 2015–2016 (P_{linear} =0.008; Supplemental Table 2, Online Appendix A). We observed a quadratic trend (P = 0.02) in the prevalence of participants with total cholesterol >240 mg/dL, decreasing from 14% in 2007–2010 to 11% in 2011–2012 and then remained unchanged to 11% in 2015–2016.

Cardiovascular Health Stratified by Socioeconomic Status: Low Socioeconomic Status

Among participants in the low socioeconomic stratum, the prevalence of participants with an ideal blood pressure (<120/80 mm Hg) decreased significantly from 50% (95% CI 44%–56%) in 2007–2010 to 38% (95% CI 29%–47%) in 2015–2016 (P_{linear} =0.02; Supplemental Table 3, Online Appendix A). The prevalence of ideal fasting blood glucose less than 100 mg/dL showed a quadratic trend, increasing from 43% in 2007–2010 to 51% in 2013–2014 but then decreasing dramatically to 33% in 2015–2016 ($P_{quadratic}$ =0.005). Additionally, the prevalence of ideal healthy diet (ie, 2 components) declined from 28% in 2007–2010 to 18% in 2013–2014 but then increased to 26% in 2015–2016 ($P_{quadratic}$ =0.001).

Sensitivity Analysis

Among population in high-income status (ie, poverty income ratio >3.5), there was a stable prevalence of ideal cardiovascular health at ~50% from 2007–2010 to 2013–2014, with a decline in the prevalence to 42% in 2015–2016 ($P_{quadratic}$ =0.02; Supplemental Figure 2, Online Appendix A). Additionally, the prevalence of ideal cardiovascular health among individuals with 12 years of education showed a linear trend (P = 0.01), increasing from 19% in 2007–2010 to 29% in 2015–2016 (Supplemental Figure 3, Online Appendix A). However, we did not observe any trends in the prevalence of ideal cardiovascular health among participants with middle income status (ie, poverty income ratio between 1.50 and 3.49) and some college attainment (Supplemental Figures 2 and 3).

DISCUSSION

In summary, we demonstrated that the ideal cardiovascular health, as measured by the AHA's Life's Simple 7 metrics, has continued to decline despite the economic recovery. We noted 25% higher odds of fasting blood glucose 126 mg/dL and 15% higher odds of obesity in the postrecession period from 2011–2016 as compared with recession period 2007–2010. The prevalence of the ideal fasting blood glucose metric was noted to decline across all socioeconomic strata, while the prevalence of obesity was noted to increase in the high socioeconomic stratum only. We demonstrated that the adverse cardiovascular health effects were present across all socioeconomic strata of US adults. Finally, we also demonstrated that the economic fluctuations had a greater impact on the participants in high and low socioeconomic stratum.

There are multiple mechanistic explanations for our findings. Economic hardship is a well-described physical, cognitive, psychological, and social stressor.[19] Stressful experiences have previously been linked to both adverse behavioral mechanisms and direct pathophysiological mechanisms. The behavioral mechanisms may include maladaptive responses like binge drinking and pathophysiological mechanisms like overactivation of the sympathetic nervous system and endocrine dysregulation.[20] These pathways have multiplicative effects that may lead to cardiovascular diseases. This complex pathophysiology may even begin in newborns.[21] There are other important practical considerations. Unemployment rose to unprecedented levels in the United States during the economic recession. This was coupled with a 25% rise in adults that had incomes below 200% of the federal poverty levels.[22] This unemployment likely contributed to an additional 5 million Americans being without health insurance, leading to a total of 50 million uninsured Americans. This was in the context of already declining health insurance coverage rates between the years 2000 and 2007.[22] This economic difficulty may also partially explain the rising prevalence of obesity and diabetes over the course of the study periods via an inability to secure key medication and preventive strategies. Obesity and diabetes mellitus can be resource-intensive chronic diseases.[23] The cornerstones of management include nutritious food intake, regular exercise, and for diabetes mellitus, access to hypoglycemic medications. There is clear evidence that all of these management strategies, particularly access to medications, are grossly disrupted in financial hardship.[24]

Our investigation adds to the existing literature base on cardiovascular health outcomes related to the economic recession. The results of longitudinal cohort from the Multi-Ethnic Study of Atherosclerosis showed a significant increase in blood pressure and fasting blood glucose among US adults posteconomic recession.[3] Furthermore, younger adults, highly educated individuals, and home owners were more likely to have the deleterious effect of economic recession on blood pressure and fasting blood glucose than their counterparts.[3] To the best of our knowledge, our investigation is the first to study the aggregate effect of multiple cardiovascular behaviors and risk factors after the economic depression. This offers a more nuanced view of which ill cardiovascular health effects have recovered after the economic recession. Data from Centers for Disease Control and Prevention (CDC) showed a steady decline in rates of all cardiovascular disease, heart disease, and stroke mortality between 2000 and 2011.[25] However, the decline in mortality rates among all three categories slowed substantially after 2011.[25] Hence, the decline in ideal cardiovascular health that we demonstrated may itself provide the mechanistic explanation for the slowed decline of cardiovascular mortality rates that have been previously described in the period after the economic depression. Study assessing data from the World Health Organization (WHO) on 26 European Union countries had previously demonstrated that a 1% rise in unemployment rates led to an increase in age-specific cardiovascular mortality among males between the years 1980 and 2007.[26] Our investigation also provides a mechanistic explanation for this data. Lastly, the economic recession has also impacted the cardiovascular health in other countries, such as the United Kingdom.[27] The data including 1.36 million survey responses ages 16201364 years from the Quarterly Labour Force Survey of the United Kingdom showed a ~3% rise in unemployment during the economic recession. Following the economic recession, nearly 1% increase in poor cardiovascular health was reported, despite

the presence of a robustly funded public health system in the United Kingdom.[27] Our results suggest that the effect may be even more dramatic in the US population.

Our study also holds public health importance. The increasing prevalence of poorly controlled fasting blood glucose especially in high socioeconomic strata is particularly disconcerting. A major increase (~12%) in the prevalence of obesity among participants from high socioeconomic strata might explain the aforementioned observation. The 2010 Global Burden of Disease report noted a rapidly rising worldwide disability-adjusted life year burden conferred by obesity and diabetes mellitus.[28] Other important cardiovascular risk factors were also noted to having a rising burden between 1990 and 2010. These concepts were likely synergistic in the emergence of ischemic heart disease and stroke as the pathologies that accounted for 2 of the highest burdens of disability life-adjusted years worldwide after the economic recession.[28] Needless to say, the rising prevalence of diabetes mellitus also confers a significant cost for the health system overall. The estimated cost of diabetes treatment is already thought to be well more than US$100 billion yearly based on cost-of-illness studies.[29] Moreover, the lack of improvement or widening in preexisting cardiovascular health disparities and inequities as a result of the economic recession was of great concern to us. For example, we noted in our study population that participants in the lowest socioeconomic stratum had the greatest prevalence of elevated fasting blood glucose levels (~15%). Copeland et al also described that health outcomes worsened disproportionately among English women with the lowest levels of educational attainment in the period after the economic recession.[30] Finally, we note that the economic recession and decline in ideal cardiovascular health measures coincided with a reduction in health care spending by the US government.[31] This is of particular concern to us as cuts in health care funding in an era when ideal cardiovascular health is quantifiably worsening may yield a potential endless loop of negative health outcomes.

The decline in ideal cardiovascular health may be addressed by intervention targeting the modifiable factors such as healthy diet components and ideal physical activity levels. These are relevant to subjects of all socioeconomic strata. Ideal diet, particularly among individuals of low socioeconomic status, may be addressed via reduction of food insecurity. Food insecurity is a term that refers to the inability to afford nutritious food to sustain a healthy lifestyle.[32] Food insecurity has been associated with a higher prevalence of diabetes mellitus and worsened metabolic control in prior NHANES surveys.[32,33] Food insecurity may addressed via the reduction of food desserts in lower socioeconomic status neighborhoods,[34] encouraging individuals to participate in underused food-assistance programs,[35] and avoiding budget cuts to federal food assistance programs such as the Supplemental Nutrition Assistance Program.[36] The 2018 Physical Activity Guidelines also outlined numerous useful strategies for increasing the uptake of physical activity among Americans—professional- and peer-guided groups; community-wide campaigns; and mindful community design to encourage physical activity.[37]

We acknowledge that our investigation has numerous limitations. Causality cannot be established from cross-sectional surveys such as the NHANES data. The cross-sectional nature of NHANES data limits our ability to study measures of disease frequency and intraindividual trends in ideal cardiovascular health over time. Furthermore, residual

confounding may have influenced the trends we observed (eg, our analyses does not capture access to medications or ability to pay for medications). Because of the lack of geographic identifiers such as state or county, we cannot assess the regional trends in the prevalence of cardiovascular health from the NHANES data. However, the population-level viewpoint still offers numerous important insights into cardiovascular disease risk factors. As the physical activity questionnaires changed substantially from 2007–2008 onward,[17] we are unable to compare the cardiovascular health metrics among participants prior to NHANES 2007–2008 cycle. Cardiovascular diseases such as ischemic heart disease, stroke, and peripheral arterial disease typically have long induction and latency periods. Hence, it is unlikely that we have captured the full extent of the cardiovascular disease burden that resulted from the economic depression. This will require further prospective research.

CONCLUSIONS

Despite economic recovery, we witnessed the rising prevalence of fasting hyperglycemia and obesity and declining prevalence of overall ideal cardiovascular health, especially among high and low socioeconomic strata.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding:

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CLINICAL SIGNIFICANCE

- Cardiovascular health, as measured by the American Heart Association's Life's Simple 7 metrics between economic recession (2007–2010) and economic recovery (2011–2016) was assessed.

- From 2007–2010 to 2011–2016, US adults showed a decline in mean cardiovascular health score driven by increasing prevalence of obesity and impaired fasting glucose.

- Individuals from high- and low-socioeconomic strata showed decreasing prevalence of ideal cardiovascular health.

- Cardiovascular health has continued to decline despite economic recovery.
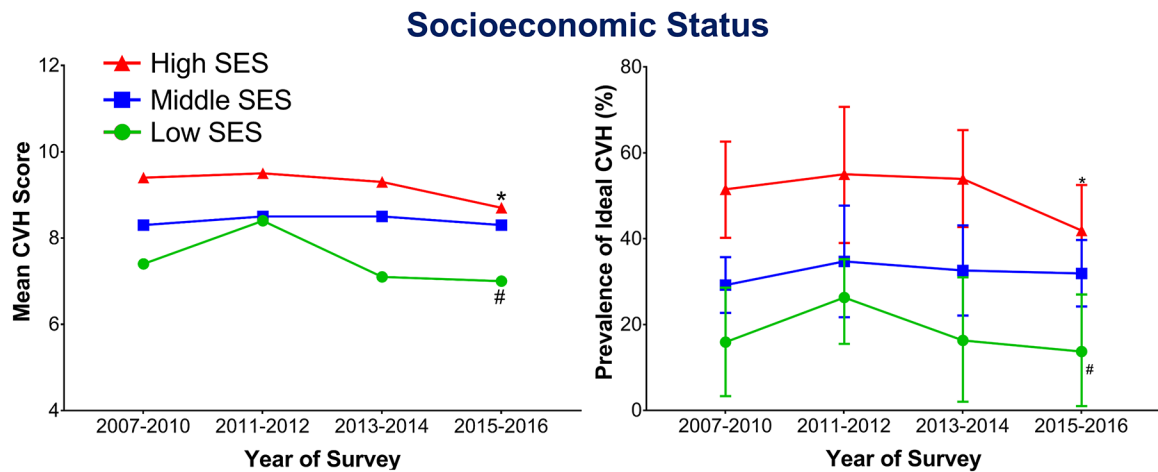
Figure 1.
The trends in mean (**A**) and ideal (**B**) cardiovascular health according to socioeconomic status by National Health and Nutrition Examination Survey cycle. (**A**) The symbols indicate covariate adjusted mean cardiovascular health. The red triangle with redline represents trends of mean cardiovascular health in participants from high socioeconomic strata (P_{linear} =0.007). The blue square with the blue line represents trends of mean cardiovascular health in participants from middle socioeconomic strata (P_{linear} and $P_{quadratic}$ >0.05). The green circle with the green line represents trends of mean cardiovascular health in participants from low socioeconomic strata ($P_{quadratic}$ =0.007). Values were estimated from multivariable linear regression analysis including age, sex, race, insurance status, and number of health care visits. Trend *P* values were estimated from multivariable logistic regression analysis including age, sex, race, insurance status, number of health care visits, and Bonferroni correction for multiple testing. * denotes trend *P* value of 0.007; # denotes trend *P* value of 0.007. (**B**) The symbols indicate covariate adjusted percentage prevalence with 95% confidence interval (error bars). The red triangle with redline represents trends of ideal cardiovascular health in participants from high socioeconomic strata ($P_{quadratic}$ =0.01). The blue square with the blue line represents trends of ideal cardiovascular health in participants from middle socioeconomic strata (P_{linear} and $P_{quadratic}$>0.05). The green circle with the green line represents trends of ideal cardiovascular health in participants from low-socioeconomic strata ($P_{quadratic}$ =0.02). Values were estimated from multivariable linear regression analysis including age, sex, race, insurance status, and number of health care visits. Trend *P* values were estimated from multivariable logistic regression analysis including age, sex, race, insurance status, number of health care visits, and Bonferroni correction for multiple testing. * denotes trend *P* value of 0.01; # denotes trend *P* value of 0.02.

Table 1

Characteristics of American Adults From NHANES 2007–2016

Characteristic	NHANES 2007–2010 No.	NHANES 2007–2010 Prevalence (95% CI)	NHANES 2011–2012 No.	NHANES 2011–2012 Prevalence (95% CI)	NHANES 2013–2014 No.	NHANES 2013–2014 Prevalence (95% CI)	NHANES 2015–2016 No.	NHANES 2015–2016 Prevalence (95% CI)
Age, years	4369	45 (32–58)	2012	46 (33–59)	2102	46 (32–59)	2017	47 (32–60)
Age Group								
20–29	707	20 (18–22)	362	18 (15–21)	335	19 (16–21)	318	19 (17–21)
30–39	709	18 (16–19)	372	18 (15–21)	361	18 (16–21)	330	17 (15–19)
40–49	790	20 (18–23)	347	20 (16–23)	397	19 (16–23)	339	18 (15–21)
50–59	730	19 (17–21)	330	19 (16–21)	373	19 (16–22)	352	18 (16–21)
60–69	692	12 (10–13)	314	15 (12–17)	341	15 (12–17)	373	17 (15–20)
70	741	11 (10–12)	287	11 (10–13)	295	11 (8–13)	305	10 (8–12)
Sex								
Male	2122	49 (47–51)	1025	49 (46–52)	1013	49 (47–51)	988	49 (47–51)
Female	2247	51 (49–53)	987	51 (48–54)	1089	51 (49–53)	1029	51 (49–53)
Race								
Non-Hispanic White	2111	70 (65–74)	787	67 (59–75)	947	67 (60–74)	694	64 (55–73)
Non-Hispanic Black	742	11 (8–13)	445	11 (7–16)	381	11 (8–14)	396	11 (6–16)
Mexican American	815	8 (6–11)	221	8 (4–12)	278	9 (6–12)	334	8 (4–13)
Other	701	11 (9–14)	559	14 (10–17)	496	13 (9–17)	593	17 (13–20)
Family Poverty Income Ratio								
3.50	1223	41 (38–44)	559	38 (30–46)	619	39 (31–46)	535	39 (33–44)
1.30–3.49	1541	34 (31–37)	647	34 (29–38)	674	32 (30–35)	731	35 (31–39)
<1.30	1605	25 (23–28)	806	28 (23–33)	809	29 (21–37)	751	27 (23–31)
Education								
12 year	2275	42 (38–46)	876	36 (31–42)	894	36 (29–43)	910	37 (29–44)
Some College	1166	29 (27–31)	595	32 (29–35)	653	33 (29–36)	588	32 (27–36)
College Graduate	922	29 (26–32)	540	32 (25–38)	554	31 (26–36)	519	32 (24–40)
Socioeconomic Status								
High	1125	38 (35–41)	530	37 (29–44)	592	37 (29–45)	511	37 (32–43)
Middle	2506	52 (49–55)	1172	53 (47–60)	1212	53 (48–58)	1217	55 (50–59)

Characteristic	NHANES 2007–2010		NHANES 2011–2012		NHANES 2013–2014		NHANES 2015–2016	
	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)
Low	732	9 (8–11)	309	10 (8–13)	297	9 (6–13)	289	8 (6–10)
Insurance Status	4369	80 (79–82)	2012	80 (77–84)	2102	82 (78–85)	2017	86 (82–89)
Number of Health Care Visits								
None	752	16 (14–18)	324	15 (12–18)	329	15 (11–18)	352	17 (16–19)
1 to 3	1969	48 (46–51)	934	47 (43–51)	976	48 (44–52)	941	50 (47–53)
4	1647	36 (33–38)	754	38 (35–41)	797	37 (35–40)	724	33 (30–36)

CI = confidence interval; NHANES = National Health and Nutrition Examination Survey; No. = number.

Table 2

Age Standardized Weighted Prevalence of Cardiovascular Health Metrics Among US Adults–NHANES 2007–2016

Cardiovascular Health[‡]	NHANES 2007–2010*		NHANES 2011–2012*		NHANES 2013–2014*		NHANES 2015–2016*		Trend P value[†]	
	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	Linear	Quadratic
Smoking										
Current	920	21 (19–22)	395	19 (16–23)	410	19 (15–23)	392	19 (16–22)	0.87	0.46
Former	433	11 (10–12)	190	10 (7–12)	206	10 (8–12)	219	13 (10–16)	0.12	0.33
Never	3016	68 (66–71)	1427	71 (67–74)	1486	71 (67–75)	1406	68 (64–72)	0.33	0.21
Physical Activity										
None	1198	22 (20–24)	460	21 (17–25)	530	24 (23–26)	547	21 (18–25)	0.66	0.16
Intermediate	1002	25 (23–27)	521	25 (21–30)	546	27 (24–30)	483	26 (23–30)	0.48	0.29
Ideal	2169	53 (50–55)	1031	54 (50–57)	1026	49 (46–52)	987	52 (50–55)	0.19	0.04
Body Mass Index (kg/m²)										
30	1624	34 (32–36)	731	35 (31–39)	782	37 (35–39)	821	41 (36–45)	0.005	0.50
25–29.9	1507	34 (32–36)	652	34 (31–36)	673	33 (31–36)	654	32 (30–34)	0.27	0.94
<25	1238	32 (30–34)	629	31 (27–36)	647	30 (27–33)	542	27 (23–31)	0.03	0.62
Healthy Diet Score										
0–1 components	3353	78 (77–80)	1510	78 (75–82)	1649	79 (77–82)	1522	79 (76–82)	0.50	0.55
2 components	1016	22 (20–23)	502	22 (18–24)	453	21 (18–23)	495	21 (18–24)		
Total Cholesterol (mg/dL)										
>240	579	13 (12–14)	215	11 (9–13)	227	11 (9–13)	248	13 (10–15)	0.91	0.09
200–239	1796	39 (36–41)	862	44 (41–47)	852	40 (36–45)	834	39 (36–43)	0.27	0.50
<200	1994	48 (46–50)	935	45 (42–49)	1023	48 (44–53)	935	48 (44–52)	0.24	0.76
Blood Pressure (mm Hg)										
140/ 90	641	11 (10–12)	273	11 (10–13)	284	12 (9–14)	338	13 (11–15)	0.21	0.96
120–139/80–89	1618	36 (34–38)	801	40 (37–43)	751	34 (31–38)	798	39 (36–43)	0.64	0.23
<120–80	2110	53 (50–56)	938	49 (45–52)	1067	54 (51–57)	881	48 (43–52)	0.76	0.15
Fasting Blood Glucose (mg/dL)										
126	517	8 (7–9)	240	9 (6–11)	237	10 (8–12)	309	12 (10–14)	0.003	0.40
100–125	1867	42 (40–44)	786	39 (37–42)	788	35 (31–38)	926	46 (42–51)	0.66	<0.001
<100	1985	50 (47–53)	986	52 (49–55)	1077	55 (51–60)	782	42 (37–46)	0.04	<0.001

Cardiovascular Health[‡][§]	NHANES 2007–2010[*]		NHANES 2011–2012[*]		NHANES 2013–2014[*]		NHANES 2015–2016[*]		Trend P value[†]	
	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	Linear	Quadratic
Cardiovascular Health[§]	4364	8.18 (8.07–8.29)	2012	8.23 (8.06–8.40)	2100	8.19 (8.04–8.34)	2012	7.94 (7.73–8.16)	0.02	0.02
Number of Ideal Cardiovascular Health Metrics										
0	116	2 (1–3)	53	2 (2–3)	55	2 (2–3)	59	3 (2–4)	0.47	0.79
1	601	11 (10–13)	290	15 (12–17)	273	12 (11–14)	331	16 (12–19)	0.22	0.76
2	1095	23 (21–25)	454	20 (18–23)	483	22 (19–25)	555	26 (22–29)	0.13	0.27
3	1183	27 (25–29)	512	25 (23–28)	506	24 (21–27)	501	24 (21–27)	0.10	0.18
4	817	21 (19–23)	382	20 (18–23)	436	22 (19–25)	319	18 (15–21)	0.39	0.35
5	435	12 (10–13)	239	12 (10–15)	266	13 (11–15)	198	11 (8–13)	0.71	0.17
6	122	4 (3–5)	82	4 (3–6)	83	5 (3–6)	54	3 (1–5)	0.47	0.11

CI = confidence interval; NHANES = National Health and Nutrition Examination Survey; No. = number.

[*] Direct method for age standardization was performed using the US 2000 census population age-groups 20–29, 30–39, 40–49, 50–59, 60–69, 70 years or older.

[†] The orthogonal polynomial model including age groups, race, sex, insurance status, number of health care visits, and Bonferroni correction for multiple testing was used to assess the linear and quadratic trend P value across the survey years.

[‡] All the participants 20 years or older with available cardiovascular health metrics were included.

[§] Age, sex, race, and insurance status-adjusted mean cardiovascular health metric with 95% CI from NAHNES 2007–2016.

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Table 3

Adjusted Odds Ratio of Cardiovascular Health Metrics in the Post-Recession Years (2011–2016) Compared With Recession Years (2007–2010) From NHANES

	Odds Ratio (95% CI)
Cardiovascular Health[*]	2011–2016 vs 2007–2010
Smoking	
Current	0.95 (0.81–1.12)
Former	1.04 (0.84–1.27)
Never	1.03 (0.89–1.18)
Physical Activity	
None	0.98 (0.84–1.14)
Intermediate	1.05 (0.87–1.26)
Ideal	0.98 (0.85–1.12)
Body Mass Index (kg/m^2)	
30	1.15 (1.01–1.30)
25–29.9	0.96 (0.85–1.09)
<25	0.89 (0.76–1.05)
Healthy Diet Score	
0–1 components	1.05 (0.89–1.24)
2 components	0.96 (0.81–1.13)
Total Cholesterol (mg/dL)	
>240	0.86 (0.71–1.04)
200–239	1.07 (0.92–1.25)
<200	1.01 (0.85–1.19)
Blood Pressure (mm Hg)	
140/ 90	1.06 (0.86–1.32)
120–139/80–89	1.06 (0.91–1.23)
<120–80	0.92 (0.78–1.08)
Fasting Blood Glucose (mg/dL)	
126	1.26 (1.01–1.59)
100–125	0.91 (0.77–1.06)
<100	1.03 (0.86–1.23)

CI = confidence interval; NHANES, National Health and Nutrition Examination Survey.

[*] Adjusted for age, sex, race, insurance status, and number of health care visits.

Table 4

Age Standardized Weighted Prevalence of Cardiovascular Health Metrics in Higher Socioeconomic US adults-NHANES 2007–2016

Cardiovascular Health[‡]	NHANES 2007–2010[*]		NHANES 2011–2012[*]		NHANES 2013–2014[*]		NHANES 2015–2016[*]		Trend P value[†]	
	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	No.	Prevalence (95% CI)	Linear	Quadratic
Smoking										
Current	131	14 (12–16)	56	9 (7–11)	48	9 (5–13)	56	11 (8–15)	0.66	0.07
Former	105	10 (8–13)	57	11 (8–15)	59	10 (7–13)	49	12 (7–17)	0.59	0.74
Never	889	76 (73–79)	417	80 (75–84)	485	81 (77–86)	406	77 (71–83)	0.96	0.06
Physical Activity None	187	14 (11–17)	78	15 (9–21)	126	20 (17–23)	99	16 (12–20)	0.22	0.007
Intermediate	326	31 (27–35)	183	33 (27–39)	195	33 (29–38)	149	30 (24–36)	0.72	0.27
Ideal	612	55 (52–59)	269	52 (45–58)	271	46 (42–51)	263	54 (50–57)	0.42	0.002
Body Mass Index (kg/m²)										
30	384	30 (26–34)	162	29 (22–36)	177	31 (26–35)	198	42 (36–48)	0.003	0.36
25–29.9	400	36 (33–39)	182	37 (32–43)	214	38 (31–44)	164	32 (27–37)	0.24	0.43
<25	341	34 (29–39)	186	34 (24–43)	201	32 (26–38)	149	26 (20–32)	0.06	0.87
Healthy Diet Score										
0–1 components	799	78 (74–82)	385	76 (71–81)	453	79 (75–82)	369	77 (73–81)	0.72	0.68
2 components	241	22 (18–26)	143	24 (18–29)	138	21 (18–25)	141	23 (19–27)		
Total Cholesterol (mg/dL)										
>240	135	12 (9–15)	56	12 (9–16)	75	13 (10–16)	69	15 (10–20)	0.33	0.86
200–239	498	42 (39–46)	247	45 (39–51)	254	42 (35–50)	227	44 (36–52)	0.48	0.83
<200	492	45 (41–50)	227	43 (37–48)	263	43 (37–48)	215	41 (35–47)	0.94	0.85
Blood Pressure (mm Hg)										
140/ 90	147	10 (8–12)	68	12 (8–16)	74	11 (9–14)	66	13 (8–17)	0.59	0.82
120–139/80–89	422	36 (32–40)	211	39 (34–44)	192	32 (28–37)	211	42 (36–47)	0.95	0.06
<120–80	556	54 (50–58)	251	49 (42–55)	326	56 (51–62)	234	46 (38–53)	0.75	0.12
Fasting Blood Glucose (mg/dL)										
126	101	6 (5–8)	38	6 (2–10)	52	7 (5–10)	70	12 (8–16)	0.04	0.85
100–125	484	42 (38–45)	216	42 (35–49)	222	35 (31–39)	228	47 (41–53)	0.96	0.001
<100	540	52 (49–56)	276	52 (45–59)	318	57 (52–63)	213	41 (33–49)	0.22	0.002

CI = confidence interval; NHANES = National Health and Nutrition Examination Survey; No. = number.

*
Direct method for age standardization was performed using the US 2000 census population age-groups 20–29, 30–39, 40–49, 50–59, 60–69, 70 years or older.

†
The orthogonal polynomial model including age groups, race, sex, insurance status, number of health care visits, and Bonferroni correction for multiple testing was used to assess the linear and quadratic trend *P* value across the survey years.

‡
All the participants 20 years or older with available cardiovascular health metrics were included.